AI Based COVID-19 Identification From Chest X-Rays: A Review

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Abstract- *Infectious diseases pose a threat to human life and could affect the whole world in a very short time. Corona-2019 virus disease (COVID-19) is a example of such harmful diseases. COVID-19 is a pandemic of an emerging infectious disease, called coronavirus disease 2019 or COVID-19, caused by the coronavirus SARS-CoV-2, which first appeared in December 2019 in Wuhan, China, before spreading around the world on a very large scale. The continued rise in the number of positive COVID-19 cases has disrupted the health care system in many countries, creating a lot of stress for governing bodies around the world, hence the need for a rapid way to identify cases of this disease. Medical imaging is a widely accepted technique for early detection and diagnosis of the disease which includes different techniques such as Chest X-ray (CXR), Computed Tomography (CT) scan, etc. In this paper, we propose a methodology to investigate the potential of deep transfer learning in building a classifier to detect COVID-19 positive patients using CT scan and CXR images.*
From the results of the experiments it was found that by considering each modality separately, the VGGNet-19 model outperforms the other three models proposed by using the CT image dataset where it achieved 88.5% precision, 86% recall, 86.5% F1-score, and 87% accuracy while the refined Xception version gave the highest precision, recall, F1- score, and accuracy values which equal 98% using CXR images dataset. These results enables to automatize the process of analyzing chest CT scans and X-ray images with high accuracy and can be used in cases where RT-PCR testing and materials are limited.

Keywords- CT(Computed tomography),PET(Positron emission tomography) ANN(Artificial Neural Network) Covidetc.

I. INTRODUCTION

Coronaviruses (nicknamed CoV) are a family of viruses of varying severity: depending on the government website, they can cause simple colds or more serious conditions such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). These are common RNA viruses of the Coronaviridae family that cause digestive and respiratory infections in humans and animals.

The World Health Organization (WHO) has found COVID-19, a novel coronavirus illness, in Wuhan, Hubei, China (https://www.who.int/emergencies/diseases/novel coronavirus2019/technical-guidance/naming the coronavirus-disease-(covid-2019) .

Previous research has linked the virus's origin to a fish market in Wuhan, and it has also been suggested that the virus was spread to humans by bats. This virus is the most contagious and rapidly spreading member of the Coronavirus family, and it has become a public health emergency as cases have grown despite a lack of health facilities and resources.

Coronavirus disease 2019 (COVID-19) is an infectious disease triggered by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease was initially identified in December 2019 in Wuhan, China, and has since spread globally [2, 3]. At the outset, a patient with pneumonia of mysterious cause was first reported to the WHO Country Office in China on 31 December 2019 [4]. Since then, the disease has spread all over the globe in enormous numbers and is declared a pandemic. As of 16 September 2020, there were 29356292 confirmed COVID-19 cases in various countries, territories, or areas, and 930260 people had lost their lives [5], and the numbers are still rising. Although radiological imaging is not recommended for diagnostics as the patient arrives in the clinic, a chest X-ray is often useful to monitor treatment outcomes and comorbidities in seriously ill patients. The detection of COVID-19 from chest X-ray and its differentiation from lung diseases with identical opacities is a puzzling task that relies on the availability of expert radiologists. Recently, several researchers have reported the use of AI-based tools in solving image classification problems in healthcare, based on training with X-ray images, CT scans, histopathology images, etc. Deep learning is an extremely powerful tool for learning complex, cognitive problems [6, 7], and the frequency of their use and evaluation in different problems is increasing [8]. In the present study, we have made use of a deep learning algorithm using the convolutional neural network (CNN) that can efficiently detect COVID-19 from chest X-ray images for swift diagnosis.

II. LITERATURE REVIEW

- The novel coronavirus is a disease that is transmissible from human to human via cough or sneez droplets from an infected person (Chen et al. 2020). It is spread by coming into contact with an infected person, touching something that has the virus on its surface, and then touching their mouth, eyes, ears, or nose. High fever, cough, sore throat, difficulty breathing, and diarrhea are all common signs of coronavirus infection. Fever is the first symptom, and it might proceed to pneumonia. Shortness of breath, chest tightness, and other dangerous infections are all possible complications.
- The elderly and those with pre-existing disorders have a higher chance of death (Bansal and Sridhar 2020). Cardiovascular disease, asthma, diabetes, and hypertension are examples of high-risk people. Only a few cases have been reported in children (Zunyou and McGoogan 2020)
- The WHO has announced a strategy to limit the spread of the virus from infected people to healthy people by detecting them and isolating them from others. On the other hand, laboratory tests were used as reference tests to detect COVID-19 patients such as PCR, antigen, and antibodies. However, these tests have certain limitations regarding the accuracy of the results which can often produce false alarms, the availability of laboratories that can serve the test, the time required to obtain the results, the cost of the test, the phase of infection.
- All of these limitations risk a high spread of the disease among other peoples by patients (Elpeltagy and Sallam 2021). Given the low sensitivity of the RT-PCR test, designing other automated and reliable methods to screen COVID-19 patients is currently a major challenge for researchers. As a solution to these problems and since the coronavirus attacks our epithelial cells and damages our lungs, medical imaging techniques, such as chest computed tomography and chest X-ray offer a noninvasive alternative to identify COVID-19 and diagnose infected lungs. While selectively testing false negative PCR cases.
- In this context, artificial intelligence models intervene, which represents a quick solution for this type of problem. More specifically, the deep learning (DL) approach has been very popular and successfully used in the classification of medical images due to its high accuracy. The major goal of this research is to use pre-trained deep learning architectures to refine and develop an automated tool for detecting and diagnosing COVID- 19 in chest X-ray and Computed Tomography images (Elpeltagy and Sallam 2021).
- Asnaoui et al. achieved 92.18% accuracy (for Inception-ResNetV2) to classify the chest X-ray and CT images into bacterial pneumonia, coronavirus, and normal classes.
- Ozturk et al. developed deep learning based binary classification (COVID vs. no findings) and multiclass classification (COVID vs. no findings vs. pneumonia) models that achieved the highest accuracies of 98.08% and 87.02%, respectively.
- Waheed et al. developed a method to generate synthetic chest X-ray (CXR) images by creating an Auxiliary Classifier Generative Adversarial Network- (ACGAN) based model CovidGAN. The binary classification models achieved an accuracy of 85% for the model based on original images (training dataset consisted of 331 COVIDCXR images and 601 normal-CXR images). However, the accuracy increased to 95% for the model trained with the combined use of original and augmented images (training dataset consisting of actual images plus CovidGAN generated 1399 synthetic images of normal-CXR and 1669 synthetic COVID-CXR images). Thus, the original imagebased dataset consisted of 932 training samples (331 COVID-CXR and 601 normal-CXR images). In comparison, the combined dataset of original and synthetic images consisted of 4000 training samples (2000 COVID-CXR and 2000 normal-CXR images). They evaluated performance on 192 testing samples for the two models—namely, the model trained with original and the one with the original as well as synthetic images.
- Chouhan et al. developed a transfer learning-based approach for the prediction of paediatric pneumonia based on chest X-ray images. The ensemble model developed in the study achieved a maximum accuracy of 96.4% with a recall of 99.62% on unseen data.

III. METHODOLOGY FOR COVID-19 DETECTION USING CNN

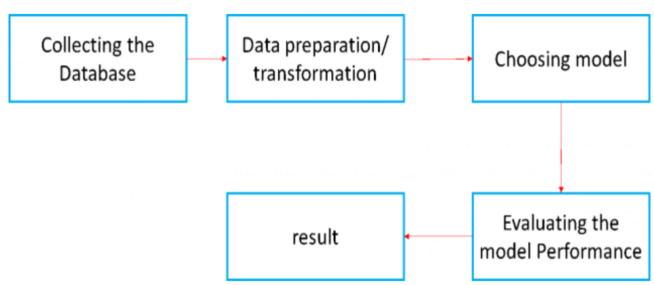


Fig.1 Methodology Block Diagram

COVID-19 positive cases detection is performed using convolutional neural networks. In particular, we used well known deep CNN models for classification of images which have are pre-trained from large image databases and retrained them to learn COVID-19 positive vs negative cases. Chest X-ray images which have been clinically diagnosed as COVID-19 positive are preprocessed and afterwards are used to retrain existing deep CNN models for image classification. X-ray images preprocessing consists of image resizing and pixel values normalization to meet the input specifications of each retrained deep CNN model. The CNN models are retrained as binary classifiers to identify positive COVID-19 againstnon-COVID-19 chest X-ray images. The retrained deep CNN models and used for testing, receiving as input new chest X-rays with unknown clinical diagnosis in order to automatically label them as positiveCOVID-19 cases or not, i.e. providing a binary decision per chest scan. The block diagram of the evaluated architecture for detection of COVID-19 positive cases from chest X-ray images is illustrated in Fig 1.

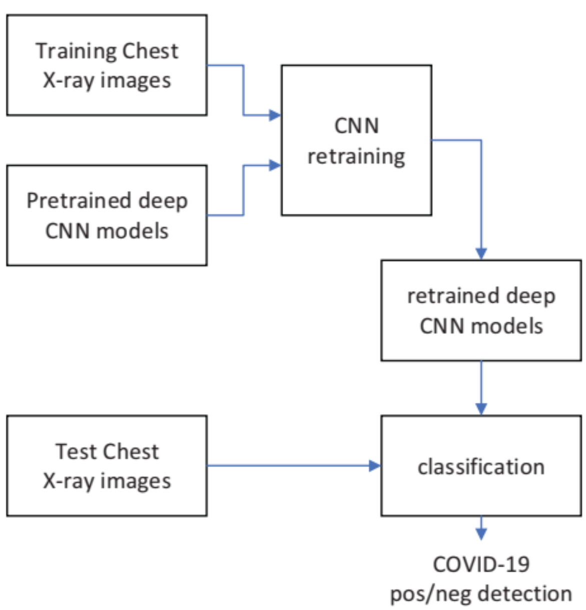
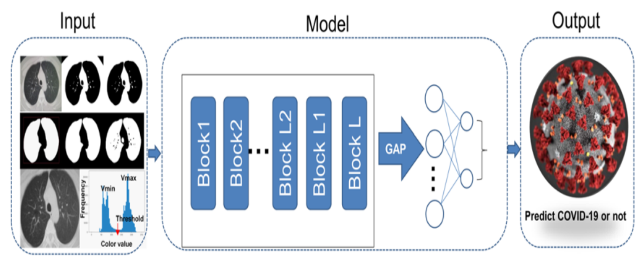


Fig.2Evaluated Architecture For Detection Of COVID-19 Positive Cases From Chest X-ray Images

III. FACILITIS REQUIRED FOR PROPOSED WORK

Our systematic pipeline for the prediction architecture is depicted in Fig. 1. The architecture consists of three main processes: (1) preprocessing of input images; (2) feature extraction of ROI images and training; and (3) classification with two fully connected layers and prediction of binary classifiers. We performed transfer learning, which involved training with a predefined model using the well-known Google Net Inception v3 CNN [16]. The network was already trained on1.2 million color images from ImageNet that consisted of1000 categories before learning from the lung radiographs in this study [17]. The entire neural network can be roughly divided into two parts: the first part used a pre-trained inception network to convert image data into one-dimensional feature vectors, and the second part used a fully connected network, mainly for classification prediction. The ROI images from each case were preprocessed and input into the model for training. The number of various types of pictures in the training set is equal, with a total of 320 images. The remaining CT images of each case were used for internal validation. In each iteration of the training process, we fetched a batch of images from the training dataset. The following parameters were used for training: we trained for 30 epochs, the initial learning rate of the pre-trained model was 0.01, and it was automatically adjusted with training; furthermore, we used adaptive moment estimation gradient descent for optimization.



IV. PROPOSED EXPERIMENTAL RESULTS

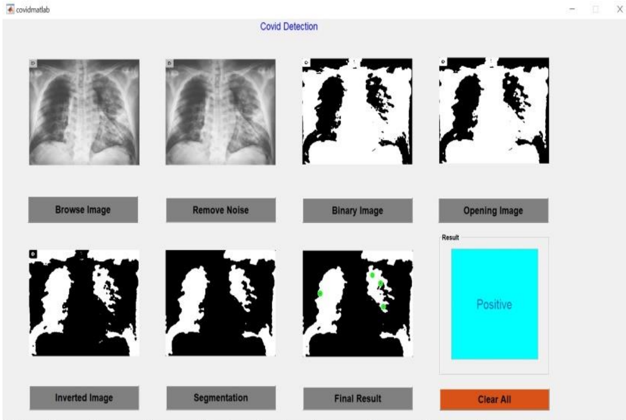
The evaluation architecture presented in Section II was
evaluated using the experimental setup described in Section III. The performance of the evaluated deep CNN models was measured in terms of classification accuracy, precision and recall (or sensitivity), i.e.

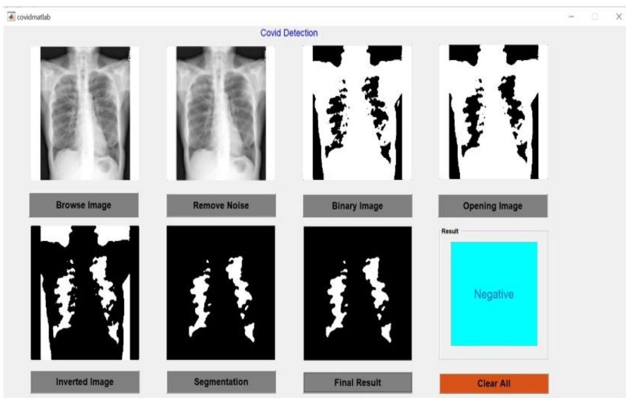
$$accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$precision = \frac{TP}{TP + FP}$$

$$recall = \frac{TP}{TP + FN}$$

	Train: A/ Test: B			Train: B/ Test: A		
Model Name	Acc	Prec	Rec	Acc	Prec	Rec
DenseNet-121	**100.00**	**100.00**	**100.00**	99.00	95.67	90.87
DenseNet-169	**100.00**	**100.00**	**100.00**	98.38	90.95	87.21
DenseNet-201	**100.00**	**100.00**	**100.00**	98.42	93.47	84.93





V. CONCLUSION

An evaluation of transfer learning using pretrained deep convolutional neural network models for COVID-19 identification using chest X-ray images. Two publicly available datasets were used in different experimental setups. In specific, we tested the binary COVID-19identification performance of several convolutional neural network models using 10-fold cross validation on each dataset separately, then we tested the transferability of the models by using one dataset for training and the other for testing and vice versa. Finally, we merged the two datasets and performed 10-fold cross validation to investigate the effect of the size of available data in accuracy, precision and recall. The experimental evaluation demonstrated the potential of building diagnostic tools for automatic detection of COVID-19 positive cases from chest X-ray images and deep convolutional neural networks and the development of larger and clinically standardized datasets would further help in this direction.

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